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Massive Open Online Courses As A Tool For Global Animal Welfare Education

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Abstract

The Animal Behaviour and Welfare Massive Open Online Course (MOOC) hosted on Coursera was a free, introductory animal welfare course. Through interrogating Coursera data and pre/post student experience surveys, we investigated student retention, student experience, changes in attitudes and changes in knowledge. The course ran for five weeks and 33501 students signed up and 16.4% (n=5501) of those received a certificate of achievement, indicating they had completed all assessments within the course. This retention rate is above the industry standard of 10%, however the value of retention rate as a metric to judge MOOC success is questionable. Instead we focus on demographics, with Coursera data estimating that 41% of learners came from Europe, 35% from North America, 11% from Asia, 6% from Oceania, 5% from South America and 2% from Africa. Most learners had completed an undergraduate degree. Despite this wide range of backgrounds, 57.2% of post course respondents (n=2399) strongly agreed that information presented was at the right level and 64.9% strongly agreed that the course was interesting. After completion, more students ($X^2(4)=132.40$, $P<0.001$) understood that animal welfare was based on the results of scientific study and significantly fewer students ($X^2(4)=361.32$, $P<0.001$) felt health was the most important part of animal welfare. Overall learners agreed the course was enjoyable and informative and 97.9% felt the course was a valuable use of their time. We conclude that MOOCs are an appropriate vehicle for providing animal welfare learning to a wide audience, but require a significant level of investment.

Keywords:

Animal welfare, animal welfare education, online learning, veterinary education

Introduction

The UK's Foresight Report into the future of global farming predicts that, over the next forty years, the world's production animal population will increase by 60-70% [1]. But the report also notes that consumers, on a global scale, are becoming more concerned with animal welfare and what that means for their purchasing habits. Animal welfare is a growing concern, not just for production animals and their consumption, but also within the study of wild animals and companion animals. Veterinary education programs now note, on an international scale, that animal welfare education is often substandard and does not adequately equip veterinary students for practice [2–4]. Furthermore, conservationists are beginning to incorporate the impact of health and human effects on the welfare of wild animals [5,6]. There is clearly both demand for and a requirement for easily accessible, international animal welfare education and advocacy.

Massive Open Online Courses (MOOCs) are internet-based courses which are conducted entirely in a virtual learning environment, feature a high student:teacher ratio, and learning occurs remotely and at the student's leisure. The first MOOC was hosted in 2008 [7] and was a credit-bearing course for 2200 students on the 'Connectivism' theory of learning. Since the 2008 course, MOOCs have become somewhat fashionable within higher education and several platforms have emerged to host these courses such as MOOC.Org, Udacity.Com, Edx.Org and Coursera.Org. Both universities and organisations can create MOOCs, for example, Coursera hosts courses from National Geographic, the Commonwealth Education Trust and the Museum of Modern Art, alongside their many academic partners.

Animal welfare is a complex topic. Teaching animal welfare involves exchanging an understanding of animal welfare science, the cultural biases which inform animal welfare and recognition of how ethical philosophy and science interact to produce animal welfare policies [8]. From a subject perspective, the '*Animal Behaviour and Welfare*' MOOC proves challenging as it must engage people with very different points of view, levels of understanding, background knowledge and levels of education. The diversity of audiences has already been considered as a barrier to MOOC uptake [9] and one of the possible contributors to the poor retention rate of students, which can be as poor as 5-10% [10]. The poor retention rate has also been attributed to users wanting different outcomes from the course, e.g. not wishing to sit examinations, or looking for entertainment rather than education [11]. Other obstacles in the delivery of MOOCs include the student workload, which is often too high, leading to some claims that the retained students are the 'MOOC survivors' [12]. Despite this, MOOCs have generally been perceived positively by both the students and the teaching staff [13], and are currently very popular.

The University of Edinburgh has partnered with Coursera.Org to produce, as of July 2014, 13 MOOCs, ranging from *'Astrobiology and the Search for Extraterrestrial Life'*, to '*Critical Thinking in Global Challenges*', '*EDIVET: Do you have what it takes to be a veterinarian?*' and '*Equine Nutrition'*. Despite the prolific nature of MOOCs, the concept is still relatively new and there is little information as to the efficacy of a course in delivering learning, how the user experiences the course, and whether they are a worthwhile use of researcher's time. In this paper we assess our own '*Animal Behaviour and Welfare*' MOOC on all three of these outcomes, using pre and post surveys of knowledge, attitudes and experience, and in-course assessments.

Materials and Methods

Course and Study Overview

The MOOC in question was hosted on the Coursera platform under the title '*Animal Behaviour and Welfare*' (coursera.org/course/animal). It was a joint program between the University of Edinburgh and Scotland's Rural College. The course was advertised as an entry-level course with no background reading required to encourage learners with little to no formal science education to take part. It was delivered over a five week period covering The Introduction to Animal Welfare, Measurements for Animal Welfare, Companion Animal Welfare, Production Animal Welfare and Captive Wild Animal Welfare. The course was delivered in English with approximately 1-3 hours of teaching time per week, delivered via video lectures and interactive flash-based presentations created via Articulate (Articulate Global Inc., 2014, New York, The United States). The course began on 14th July 2014. Each week began on a Monday with a weekly Google Hangout Session occurring on the same Friday, where the week's tutor would answer commonly raised questions on the forum. For the purposes of this evaluation, we chose to have a discrete study end date which would allow for comparison between our user surveys and the data provided via Coursera. The study end date was the 25th August, 2014, a full six weeks post the course's start. The teaching commitment from the staff was considered to be completed and no longer available and no longer available to the course participants. As we were interested in the benefits of a connectivism approach to animal behaviour and welfare teaching, it was not considered appropriate to use data post staff involvement. It was on this date that we closed the survey and recorded data from Coursera's usage statistics, although it was still possible for learners to interact with the course materials after this date.

Course Conception and Design

It could be said that the challenges of a broad user base, high user number and high staff-student ratio are integral to the MOOC format, which is based upon the learning theory of connectivism, [14]. Traditionally MOOCs adopt a connectivism theory of teaching, and these style of MOOCs are often called cMOOCs, to be contrasted with the xMOOC which is closer in style and pedagogy to the traditional classroom, with a 'sage-on-the stage' approach to teaching [15]. While the Coursera platform has been described as an xMOOC platform [16], many of the connectivism concepts are highly applicable to animal welfare science, which is a dynamic and changing science, requiring continual refreshment training. As one of the major challenges of this course was to provide animal welfare teaching which would be relevant to an international audience, the course was conceived as having a strong connectivist approach, necessitating the broad adoption of discussion boards, the production of a behind the scenes video diary, live Google HangOuts to give learners the opportunity to interact with researchers and vice versa, and learner-led study groups.

Course Content and Completion

The content of the course was predominantly custom made for the MOOC, with the exception of two interactive sessions which were adapted from continuing professional development materials created for the International Fund for Animal Welfare [17].

The five weeks of the course were given marketable titles along with their descriptive titles and stated aims (described as learning outcomes on the week's page, although not all aims strictly follow learning outcome format) as detailed in **Table 1**. In addition to these learning outcomes there were also three

126 overarching key messages which dictated the course content. These were based off of the staff
127 experience in communicating animal welfare science to an international audience and were:

128 • What we can measure we can manage.
129 • It is the animal's experience that matters.
130 • Small changes can make a big difference.

131 Each week had core content in the form of video lectures, and then a number of additional content
132 elements such as interactive sessions created in the e-learning Articulate software, interviews with
133 experts, and external links which would allow the students to seek out more information if they so
134 chose. By layering content in this manner, the aim was to accommodate for those who only had a basic
135 understanding of science, while still facilitating those learners who wanted a more comprehensive
136 learning experience.

137

138 Coursera offers two forms of completion certificate to learners who complete course-set standards.
139 These are the Signature Track certificate and the Statement of Achievement (sometimes called the
140 Certificate of Completion or Certificate of Achievement depending on Coursera documentation). To
141 receive a Signature Track certificate, a Coursera user must pay a fee of $49.00 per course within two
142 weeks of the course's start date. This payment is incurred regardless of whether the user successfully
143 completes the course. The Signature Track uses a web-cam and typing style to confirm the identity of
144 the user taking the test, and is what Coursera promotes as a 'verified certificate', and what Coursera
145 recommends for users who wish to use the course as professional development. We did not promote
146 Signature Track ourselves, but referred users to Coursera's documentation when asked. Our course
147 standard for completion was a score of at least 60% on the five multiple choice quizzes. Three attempts
148 were allowed. The quizzes were not intended to be difficult, but instead were to act as a self-check for

the learners. This was the only time learners were asked to demonstrate their knowledge in a conventional form, however demonstration and application of knowledge was observed although not quantified in student-researcher interactions on the discussion boards and Google HangOuts. No element of the course was university credit bearing or accredited by an external body. Example questions are below:

What is speciesism?

a) Allocating the same consideration to all species no matter our personal bias towards particular animals.
b) Different levels of consideration given to an animal as a consequence of their species rather than any evidence of their ability to feel positive or negative emotions.
c) Wanting to do research with as many different animals as possible

Which one of the following was not discussed as a method to enrich the environment of a commercial broiler chicken shed?

a) vegetables
b) hay or straw bales to sit on or peck at
c) perches
d) footballs
e) whole grains scattered in the wood shavings litter
f) natural daylight from windows

Course Users

The course was advertised via Coursera, the University, the Jeanne Marchig International Centre for Animal Welfare Education (JMICAWE) blog and website, the SRUC website, course tutors personal websites, and via a Behind The Scenes Video Log on YouTube and through the JMICAWE twitter website with the hashtag #EdAniWelf. At the beginning of the course, on 14th July 2014, Coursera recorded 25398 students, which rose to 33501 students by the 25th August, considered to be the end total number of students enrolled in the course. 5501 (16.4% of end total) students completed all five multiple choice assessments with a grade of at least 60% in all, qualifying them to receive a certificate of achievement. For demographic data such as gender, age, education status, highest education level and employment status, Coursera estimates percentages based on a subset of learners enrolled who have responded to the Coursera demographic survey. 95% confidence intervals and number of respondents are included for these. Learner location is based off of IP resolution and as such is not always resolved to a specific country (e.g. Europe or 'anonymous proxy IP').

Course Evaluation

The course was evaluated in two main formats. The first was through the Coursera platform as an assessment of student performance in weekly multiple choice tests. Pre and post knowledge, attitudes and experience were also assessed through surveys hosted on Survey Monkey. The survey consisted of ten questions assessing demographics, attitudes to animal welfare, knowledge of animal welfare, and learner experience. Questions were developed based on the relevant research of the MOOC literature and the authors' and course instructors' experience of teaching and were based on that used by Read et al.,(2015). First drafts of the questionnaire were circulated around the teaching staff (n=5) for comment and then further refined. The first survey was sent out on the 19th June, 2014 through Coursera emails.

Reminders were sent out on the 24th June and 2nd July. The pre survey responses were collected on the 14th July. The post-survey was sent out on the 20th August with reminder emails sent out on the 22nd August. The link remained active on the front page of the course until the 10th September when the post survey responses were collected.

The elective questionnaire was designed to assess three aspects of the learner's progress before and after the MOOC. These were: learner confidence in their animal behaviour and welfare knowledge; learner attitudes to animal behaviour and welfare; and user knowledge about animal behaviour and welfare. With a few exceptions (such as 'What is animal welfare') these were all assessed with a Likert-type scale question, with learners stating how much they agreed with a given statement on a five-point scale from 'No Agreement Whatsoever' to 'Strongly Agree'. All three sections had questions in this format to mask the different aspects of the survey to the respondents. The knowledge questions were phrased as 'true/false' statements, although the respondents answered with agreement.

Differences between pre course and post course confidence, attitudes and knowledge were assessed using X^2 tables in R (R version 3.1.1., the R Foundation for Statistical Computing). Due to the large numbers of respondents in some categories standardised residuals (as *z*-scores) are also reported.

Processing Survey Data

Users were not counted if they did not answer the first questions "What is animal welfare" resulting in 3268 usable respondents in the pre-MOOC assessment. In the post-MOOC assessment, due to the different structure of the questionnaire, users were not counted if they did not answer the question

"Did you find the course enjoyable?" resulting in 2397 usable respondents in the post-MOOC assessment. Due to discrepancies in how people entered their native language, all Chinese languages (Cantonese, Mandarin, Chinese, etc.) were described as Chinese. Brazilian Portuguese was collapsed into Portuguese, Bahasa Indonesia into Indonesian, Malay into Malayalum, and the Slovenian, Slovak and Slovene languages were collapsed into Slovene. User's educational status was collapsed into the main categories based off of 'other information' field.

Results

Demographics

A comparison of Coursera demographics at the start and end of the course, and elective survey sample pre and post course is given in Table 2. 12.87% (n=3268) of users at the start of the course responded to the elective survey (86.87% Female, 11.96% Male, 0.76% Prefer Not To Say, 0.40% Transgendered). Of these, 35.13% lived in a city, 14.01% in a rural area, 26.71% in a semi-rural or small town, 24.14% in an urban area or large town. Although the majority (67.75%) were English speakers, there were 60 native languages present overall, with Spanish being the next most prevalent at 8.08%, followed by Portuguese (3.12%) and Polish (2.45%). Coursera estimated that 41% of users came from Europe, 35% from North America, 11% from Asia, 6% from Oceania, 5% from South America and 2% from Africa. From both Coursera data and the elective surveys, there was no evidence of a particular demographic leaving the course. The majority of post-course survey respondents (93.1%, n=2232) completed the course and expected to receive a statement of achievement. A small proportion (3.6%, n=86) completed the course but did not expect to receive a statement of achievement, whereas 1.3% (n=32) expected to receive a statement of achievement without completing the course. 1.5% of the respondents (n=35) did not complete all aspects of the course and did not complete the assessments and 0.5% of the elective survey respondents (n=12) dropped out of the course or lost interest. All these respondents were kept in the post-course survey as the experience of those who dropped out or did not complete was considered to be valuable information.

Pre and Post Course Confidence

In the elective surveys users were asked to rate their knowledge of both animal behaviour and welfare. There were significant improvements in user rating of post-course confidence in these fields (Behaviour $X^2(3)=165.43$, $P < 0.001$, Welfare $X^2(3)=238.66$, $P<0.001$). The relative changes in learners knowledge self-rating is shown in **Figure 1**. Overall, significantly more learners rated their knowledge of behaviour and welfare to be 'better than average' or 'excellent' after the course.

Learners were asked whether they thought they could identify poor welfare and good welfare when they saw it. There was a change between the numbers of learners which felt they 'slightly agreed' or 'strongly agreed' with each statement after the course (poor welfare $X^2(4)=35.19$, $P<0.001$; good welfare $X^2(4)=47.76$, $P<0.001$), with significantly more learners likely to 'agree' rather than 'strongly agree' post course (poor welfare $z=3.18$, $P<0.01$, good welfare $z=3.85$, $P<0.001$) (**Figure 2**).

Pre and Post Course Attitudes

Learners were asked to rate their agreement on a 5 point scale (No agreement whatsoever to strongly agree) with the statements "All vertebrate/invertebrate animals have the capacity to suffer". There was a significant difference in pre and post course attitudes to vertebrate suffering ($X^2(4)=23.91$, $P<0.001$), with significantly more students agreeing with the statement post course ($z=3.14$,$P<0.01$), although the difference between the numbers of students strongly agreeing with the statement post course was not significant. There was no significant difference in attitudes to invertebrate animal suffering pre and post course ($P=0.06$). This is shown in **Figure 3**. The vast majority of students strongly agreed that it was

265 important to consider both the animal's mental needs (pre 92.7%, n=2954, post 91.2%, n=2105) and
266 physical needs (pre 93.1% n=2966, post 92.0%, n=2109) when thinking about its welfare.

267

268 *Pre and Post Course Knowledge*

269 In the pre and post elective surveys, students were asked to rate their agreement with a series of
270 true/false style statements on a five-point scale. The changes between these answers are given in **Table**
271 **3**. After the course significantly fewer students ($X^2(4)=361.32$, P<0.001) felt that health was the most
272 important part of animal welfare. More students ($X^2(4)=132.40$, P<0.001) understood that animal
273 welfare was based on the results of scientific study. Fewer students ($X^2(4)=130.10$, P<0.001) felt that
274 animal welfare had only recently become an issue for societies. Fewer students ($X^2(4)=86.70$, P<0.001)
275 felt that wild animals could not experience poor welfare. More students ($X^2(4)=404.90$, P<0.001) felt
276 that stereotypic behaviours were an indicator that an animal had suffered poor welfare; and more
277 students disagreed ($X^2(4)=120.54$, P<0.001) that all conservation programs considered animal welfare in
278 their strategies. These were all the expected outcomes post education. However, there was a small but
279 significant increase in the number of students slightly agreeing that it was not possible to have high
280 welfare farming systems ($X^2(4)=47.64$, P<0.001, z(post 'slightly agree')=4.01) and more students were
281 likely to strongly agree that all companion animals have excellent welfare ($X^2(4)=17.6$, P<0.001, z(post
282 'strongly agree')=2.56), both of which ran contrary to the learning objectives for the course.

283

284 Interestingly, after the course a small but significant portion of students found it harder to define what
285 good welfare was, with more responding it was neither a state of naturalness, contentment, good
286 health, or a combination of all three ($X^2(4)=45.83$, P<0.001). However the vast majority of students, both

287 before and after taking the MOOC, strongly agreed that it was important to consider both an animal's
288 mental and physical needs (**Figure 4**) with no significant difference between pre and post MOOC
289 responses for mental needs ($X^2(2)=2.19$, P=0.33) or physical needs ($X^2(2)=4.09$, P=0.13).

290 *Coursera Assessments and Engagement*

291 As might be expected, there was an ever declining number of students who watched the video lectures
292 (**Figure 5**) but across all video material an average of 5837 (±2680.2) students watched each lecture.
293 When considering only the main video lectures (e.g. excluding extra interviews with experts, archived
294 Google HangOuts and behind the scenes videos) an average of 6991 (±2333.2) students watched each
295 lecture. Over the five multiple choice assessments the average score was 89% (±0.04 percentage points)
296 and an average of 6311 (±1223.1) students took each quiz, with Week 1 being the most popular (n=8385
297 students) and Week 5 the least (n=5285 students). Note that students were able to submit quizzes post
298 the end date of our study, resulting in 5501 students receiving a statement of achievement having
299 passed all five quizzes to the 60% mark.

300

301 *Post Course Student Experience*

302 98.4% of the post-course respondents agreed or strongly agreed that the course was enjoyable
303 (total=2399) and 97.9% agreed or strongly agreed that the course was a valuable use of their time. A
304 breakdown of student experience can be found in **Table 4**. 69.0% of students agreed or strongly agreed
305 that the information they learned in the course would help them in their professional life and 90.6%
306 agreed or strongly agreed the information they learned would help them in their personal life.

307

By separating the course into three main arenas of learning, video lectures, interactive sessions and Google HangOuts, we can compare how enjoyable and informative each arena was for the students. As can be seen in **Figure 6**, most students found the various arenas to be both enjoyable and informative, with 95.0% (n=2265) of respondents agreeing or strongly agreeing that the video lectures were enjoyable and 96.3% (n=2295) agreeing or strongly agreeing that they were informative. Approximately 21.6% of respondents said the interactive sections were not applicable to them and 46.6% said the Google HangOuts were not applicable to them. However, of respondents which did choose to utilise the interactive sessions 94.2% (n=1763) enjoyed the interactives and 96.1% (n=1794) thought they were informative. Of respondents who chose to utilise the Google Hangouts, 90.2% (n=1144) enjoyed them and 93.1% (n=1192) thought they were informative. The forums, which did not contain learning material directly but facilitated the learning experience, were also popular with 92.3% (n=2213) of respondents agreeing or strongly agreeing that they were a welcoming environment and 94.5% (n=2264) agreeing or strongly agreeing that they were a safe environment. However it should be noted that the forums were also a source of stress for some users (see below).

Post Course Staff Experience

The course had five instructors (including the three authors of this paper) from SRUC and the University of Edinburgh who presented video lectures, created content, participated in Google HangOuts and managed the forum experience. In addition, ten other staff members were present in video lectures or interviews. The five instructors were not formally debriefed, but anecdotally found the experience to be exhausting but mostly positive. We estimate that each week of the course took 4 hours of pre-planning, 6 hours of script writing, 6 days of filming, 5 days of editing, and 25 hours to create the interactive sessions. During their week an instructor could spend 3 hours per day moderating the boards, and 3

hours for the HangOut and associated preparation. In addition, JM acted as a coordinator. Prior to the course start it's estimated that the coordinator spent 10 hours preparing the site and an additional 5 days of editing. During the course, the coordinator offered a more continued presence on the discussion boards (3 hours per day for 5 weeks) and each week would spend 5 hours on the Google HangOut, including preparation and archival. Overall, a staff member responsible for a week's worth of content could expect to spend 152 working hours to prepare the content (760 hours over 5 staff members). If one considers the 5501 learners who received a certificate to have fully engaged with the course, each hour of researcher time was equivalent to 7 unique certificates of achievement.

Much of the staff time was spent on the elements relating to a connectivism approach, e.g. HangOuts and discussion forum time. The high level of staff engagement with the forums was highlighted in the qualitative comments left in the post-MOOC survey. Within the forums there were issues surrounding 'animal rights' versus 'animal welfare', particularly surrounding diet choice, and this was the predominant concern raised by students in the qualitative comments of the elective survey:

> [What was the most negative part of the course?] *"Some of the comments from participants in the forums were judgmental and/or promoted their personal agendas as being the "right" or "only" way to be. An overwhelming amount of comments to get through, so I was unable to read them all."*

> [What was the most negative part of the course?] *"The forums. However, I realize that a topic such as this can cause more difficulty when discussing. I was*

disappointment[sic] *by a post from one instructor issuing a warning to someone based on a comparison that commentator used. It discouraged me from participating and it reluctantly finished the course."*

It should also be noted that staff members had a policy of non-interference with regards to posts that asked for situation specific advice or clinical consultation. We also noted that in such threads there was sometimes misinformation and poor advice given by other students, although these cases were in the minority. This did provide some of the staff with ethical dilemmas. There was also one instance of repeated abuse of staff, both of a sexual and political nature, which resulted in one user being banned from the forums. While these abuses were by far a minority of cases, the political volatility of the subject at large cannot be ignored. By taking a connectivism approach to teaching the subject of animal welfare, staff members are left vulnerable to abuse.

Discussion

The aims of this course were to:

- Provide an introduction to animal behaviour and welfare to an international audience.
- Facilitate the flow of information between animal welfare research and the public.
- Provide an accessible way to upskill current workers in animal related industries.

With a course retention rate of 16.4%, the Animal Behaviour and Welfare MOOC can be considered successful in comparison to MOOCs in general [11,18]. The large drop off in student attendance from the first learning material (Figure 5) is typical of MOOCs [18] and yet this MOOC had a shallower drop off than

most and boasted an impressive retention rate well above the industry standard of 10% and other course retention rates reported in the online and in literature (7% for Software Engineering [19], 5% for Circuits and Electronics [16], 3% Bioelectricity [11]. Over 95% of students felt that the video lectures were enjoyable and informative, which may explain the higher retention rate as courses pitched at too high a level [12] are associated with lower retention. In addition it may be that the practical need for good quality animal welfare teaching [20,21] and the ability to use the certificate as evidence of continued learning was a strong motivator for some of the students to remain within the course. The high retention rate of this MOOC may indicate the need and demand for resources such as this, and should be taken into consideration by others endeavouring to spread animal welfare science knowledge.

Retention rates are commonly used as a metric of course success, and by this metric the Animal Behaviour and Welfare MOOC was successful, however retention rate is a relatively blunt tool to use to assess the learner response to materials. As MOOCs themselves are highly variable in content, design and aims, the easily calculated retention rate has been a go-to metric to compare courses, although not without criticism [11,16]. We would argue that, despite our own success in retention rate, it does not adequately represent the student experience or course evaluation. To fully describe student satisfaction there needs to be a greater understanding of what MOOCs offer to prospective students, and what motivates learners to take MOOCs. For example, if a potential learner is curious about what animal welfare is, they may join the course, but receive the answer to their question in the course's introductory materials. They may then choose not to participate any longer in the course, their initial question answered. In terms of retention rate this situation is an abject failure, as the student has not completed the quizzes and so isn't counted as having 'completed' the course. However, in terms of that learner's experience it may in fact be a highly positive outcome as they have fulfilled their motivations

without spending more time than they wanted to. It is very difficult to capture this kind of interaction quantitatively, but this example serves as a reminder that MOOC learners are not necessarily the traditional students aiming to receive certification. The narrow focus on retention rate in MOOCs is too concentrated on certification, therefore in this evaluation we attempted to capture the learner's experience as alternative measures of success. For example, despite the wide audience and previously mentioned cultural variation in attitudes to animal welfare, 57.2% of post course respondent strongly agreed that the information presented was at the right level and 64.9% strongly agreed that the information in the course was interesting. This is a more promising indicator that the MOOC was successful in its aims to provide flexible learning for learners from a range of backgrounds. It is still not possible to gauge the experience of those who did not interact with the community or the surveys, but it would not be reasonable to assume their experience was a negative one.

Bearing in mind both the criticisms of retention rate and the overall high drop-out rate for these courses, are MOOCs a waste of educator's time? While it is difficult to say without knowing the details of time spent on other MOOCs, we suggest the relative success of this MOOC is proportional to the time spent creating the course materials and engaging with learners. Science outreach is well supported both by the Royal (Dick) School of Veterinary Studies and Scotland's Rural College, both of which have a mandate to produce impactful research. At an outreach event such as the Royal Highland Show, a single researcher might be expected to spend 10-20 hours in face-to-face time with 30-40 stakeholders at best, some for less than a minute. At 150 hours per week of the MOOC, each educator/researcher has had sustained interaction with the 5000+ students who received a statement of achievement at the end of the course. 7 certificates per 1 hour of educator/researcher time is a greater return on time investment

than a traditional, high impact face-to-face science outreach event, and this rate should increase with each iteration of the course.

The high exam scores and generally good acquisition of animal behaviour and welfare related knowledge are encouraging, but should not be overly exaggerated as these are effectively open-book exams. They can at least demonstrate basic knowledge retention and 'know-where' learning, as the information was neither unable to be recalled or found. For most of the knowledge related statements, post-MOOC agreement concurred with the learning outcomes, however there were a few statements where students agreement did not follow the intended learning outcomes, for example with significantly more students strongly agreeing that all companion animals had good welfare and slightly agreeing that it was not possible to have high welfare farming systems. While this may not be factually incorrect, it is an unexpected outcome from the teaching materials. It may be that companion animal welfare, in comparison to wild and productive welfare examples, was presented as being easier to maintain or achieve. Comparably, practical production animal welfare may have appeared more disturbing in comparison to wild and companion animal welfare. It may be that this second conclusion was reached in part because of the strong animal rights component in the forums, and this should be considered for future courses as an inevitable outcome of the connectivist approach where staff are not the only teachers. While we think it is important that students draw their own conclusions from an evidence based analysis, we also think it's important to present animal welfare science in a balanced manner, and it may be that we did not appropriately highlight welfare challenges faced by some animals. Despite this, the change in the learners' confidence to recognise good and poor animal welfare at the end of the course was very encouraging. More students were likely to agree that they were able to recognise different welfare conditions, and fewer students were likely to strongly agree. It may be

that they recognised what knowledge they did not have after the course, particularly as learners were significantly more likely to recognise that animal welfare was based on the results of scientific study. This is also seen in the significant increase in the number of students who answered that good welfare was not a combination of good health, contentment and naturalness. If, after the course, some students found animal welfare harder to define, this may reflect a greater understanding of the complexity of the subject.

While the forums and HangOuts are an important aspect of connectivism related teaching, they did present an added challenge. Connectivism has underpinned MOOC learning through promoting the role of social and cultural context within learning and is often considered to be a 'learning theory for the digital age' [22]. It identifies several trends in learning, such as the mobility of learners into different fields, the importance of informal learning (e.g. outside of a classroom environment), the uptake of life-long learning, and change from 'know-how' and 'know-what' to 'know-where', where students understand where to find learning materials, rather than memorising facts by rote. The main thrust of connectivism theory proposes that learning occurs in communities and the interaction, sharing and dialogue are integral parts of the learning process [23]. In some respects, animal behaviour and welfare, with the hotly contested issues of animal rights, is a challenge to communicate in this medium. Challenging disruptive classroom influences in an online environment is very different from the classroom, much as others have discovered before us [24]. Kellogg notes that many MOOC sceptics do not believe that the same breadth of knowledge can be achieved in an online course as in a classroom course. We recognise this conundrum, but argue that within the aim of introducing a wide user base to a subject, MOOCs have almost no rival. They should not be viewed as a replacement to classroom based learning, but as a complimentary method of further science education. We should note that 3.6% of the

post-course respondents had completed the course but did not expect to get a certificate of achievement, i.e. they had not carried out the assessments. In addition, 1.3% of respondents had not completed all aspects of the course but still expected a statement of achievement. While these are small proportions of the post-course respondents, they represent two distinct components of the MOOC-taking population: those who prioritise the learning and materials, and those who prioritise the achievement of 'finishing'. It is entirely likely that these subpopulations were under-sampled in both elective questionnaires. The MOOC sceptics may wonder which populations should be targeted, i.e. how can one encourage the learning-focussed population to increase their engagement and receive certificates, thus making them part of the 'success' output receiving certificates. We would argue this is not the function of MOOCs and, if anything, the different needs of users should be more fully catered for. More informative labelling of materials, for example, into 'core', 'additional' and 'for interest' may help to allow students to choose how much depth they wish to go into for a given subject. To this end, when we ran the course for its second iteration we are added a sixth week to pick up on some of the issues some users wanted to see more of, but marked it as 'additional' to indicate that students are not required to take this week to understand the main learning outcomes of the course.

Overall, while the 16% retention rate is an impressive indicator of the MOOC's success, we would strongly argue that those wishing to use the MOOC format to teach should adopt a multi-layered approach and investigate whether students left the course satisfied, rather than necessarily aim for a high retention. We would also encourage MOOC providers to report on their numbers, as there appears to be a tipping point in retention rate between appealing to a large general audience (many of whom are not invested in completion), and appealing to a small specific audience (who are invested in completion). Further, potential MOOC providers should consider whether they wish to spend time

creating a truly connectivist MOOC (or cMOOC), versus a less time intensive xMOOC, and whether the exchange of knowledge between researcher and learner is a key aim

Conclusions

In conclusion we are satisfied that the aims of this MOOC were met, and that it can be considered successful by most metrics. We are keen to develop the community aspect of learning, making it more friendly and approachable for users and instructors. We believe that the free distribution of animal welfare science teaching has significantly improved the animal behaviour and welfare knowledge of thousands of users, some of whom are in prime positions to make an impact in practical animal welfare. For this reason, we believe that animal welfare educators should attend to the need and desire for more animal welfare resources.

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Figure Headings

Figure 1 *Learners self-ratings of the animal behaviour knowledge and animal welfare knowledge before and after MOOC.*

Figure 2 *Learners self-ratings of their ability to recognise good and poor animal welfare pre and post MOOC.*

Figure 3 *Pre and post MOOC responses to the question "What is good welfare", * denotes P<0.001 in a Chi2* test.

Figure 4 *Pre and post MOOC agreement that it is important to provide for mental and physical needs of animals. 'Unsure or Disagree' encompasses 'Neither Agree nor Disagree', 'Slightly Disagree' and 'No Agreement Whatsoever'.*

Figure 5 *Total number of individual students which viewed each video lecture hosted on Coursera, both Signature Track (who paid $49.00 for an identification verified certificate) and Non Signature Track (who received a free, non identification verified certificate) users.*
† denotes an archived Google HangOut and does not include YouTube viewership.

Figure 6 *User agreement with learning tools being described as 'enjoyable' and 'informative'.*

580 **Table 1** *Content of Animal Behaviour and Welfare Massive Open Online Course and Learning Aims*

Week Number (Title)	Learning Outcomes
1 The Introduction to Animal Welfare (What is Animal Welfare and Why Does it Matter?)	• Recognise that animal welfare is a complex subject and involves a number of different disciplines including ethics, science and law. • Understand there are a number of different ways to define and describe animal welfare. • Understand there are international standards that can be applied to safeguard animal welfare. • Define animal sentience, i.e. that animals feel, so ultimately is the animal's own experience that counts most when considering animal welfare
2 Measurements for Animal Welfare (What We Can Measure We Can Manage)	• Recognise that what we can measure can be managed, e.g. through behavioural testing and physiological measures. • Understand that we need to be careful about keeping our perceptions and expectations of our pets separate from the animal's experience. For example, a dog's needs remain the same regardless of whether it is a shelter dog, a street dog, or a pet dog.
3 Companion Animal Welfare (The Truth About Dogs and Cats)	• Recognise the need to keep our perceptions and expectations of our pets separate from the animal's experience. • Contrast the various issues that arise as a result of the different dog situations. • Consider the role of pets in a society - surrogate child (dog), utility and sport (horse) and meat (e.g. dogs and cats). • Identify the main welfare issues for many household pets (e.g. lack of control). • Describe the specific welfare issues and solutions with dogs and cats in the shelter environment in different parts of the world
4 Production Animal Welfare (Down on the Farm)	• Recognise there are many reasons for the increased numbers of production animals and the general issues associated with an intensification of farming. • Consider the welfare challenges associated with farming pigs, poultry and dairy cows for producing animal based products. • Discuss the different points in the production cycle that can be of welfare concern. • Describe the evidence for welfare challenges in live animal transport and understand where solutions can be applied.
5 Captive Wild Animal Welfare (Lions, Tigers and Bears, Oh My!)	• Describe common conflicts between ecological conservation and animal welfare. • Describe the management of wild animals in captivity and the various ways they are kept - e.g. zoo, circus, sanctuary. • Discuss the role of the responsible zoo in conservation and animal welfare.

581 ***Table 2*** *Student demographics based on data from Coursera and the elective surveys.*

	Coursera Sample At Course Start (14/07/2014)		**Coursera Sample At Course End (25/08/2014)**		**Pre-Course Elective Survey**	**Post-Course Elective Survey**
Total Students/ Respondents	25,398 Female 72% Male 27%		33501 Female 70% Male 29%		3268 Female 86.87% Male 11.96% Prefer Not To Say 0.76% Transgendered 0.40%	2397 Female 81.44% Male 17.40% Prefer Not To Say 0.83% Transgendered 0.33%
Age Range (Years)	±2 percentage points					
	Females	Males	Females	Males		
13-19	2%	1%	2%	1%		
20-29	25%	10%	24%	10%		
30-39	16%	7%	15%	7%		
40-49	12%	3%	12%	4%		
50-59	10%	3%	10%	4%		
60-69	5%	2%	5%	2%		
70+	1%	0.70%	2%	0.80%		
Highest Education Level	±2 percentage points, based on 1,895 learners					
No Schooling Completed	0.20%		0.10%			
Some primary or elementary school	0.80%		0.70%		0.37%	0.50%
Some High School	4%		3%		3.27%	3.33%
High School Diploma	9%		9%		8.84%	7.68%
Some College but No Degree	15%		15%		25.46%	22.99%
Completed a college or university degree	40%		39%		37.91%	37.17%
Completed a postgraduate qualification (e.g. M.Sc, PhD, PGDip)	31%		33%		24.14%	28.12%

Employment Status	±2 percentage points, based on 1850 learners			
Full Time	37%	38%	42.84%	39.29%
Part Time	13%	13%	12.67%	11.51%
Unemployed	25%	13%	15.94%	16.52%
Self-Employed	12%	12%	14/72%	16.77%
Other	13%	14%	N/A	N/A
Student	N/A	N/A	13.83%	15.89%

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583 **Table 3** *Learner agreement with fact-related statements pre and post MOOC, X^2 and z-scores*
584 *given (* P<0.05, ** P<0.01, *** P<0.001)*

Statement	Agreement	Pre % of Respondents (n)	Post % of Respondents (n)	X^2 and Post z scores.
Animal health is the most important part of animal welfare.	No agreement whatsoever.	0.9% (28)	4.1% (94)	z=6.02 ***
	Slightly disagree.	5.6% (178)	14.9% (341)	z=8.42 ***
	Neither disagree nor agree.	15.6% (496)	23.5% (536)	z=5.03***
	Slightly agree.	40.0% (1271)	36.9% (843)	z=-1.38
	Strongly agree.	37.9% (1204)	20.5% (469)	z=-8.72 ***
				$X^2(4)$=361.32 ***
I understand that animal welfare is based on the results of scientific study	No agreement whatsoever.	1.5% (48)	2.1% (48)	z=1.23
	Slightly disagree.	5.2% (164)	5.7% (131)	z=0.68
	Neither disagree nor agree.	26.9% (857)	14.7% (338)	z=-7.25 ***
	Slightly agree.	35.1% (1117)	36.0% (825)	z=0.43
	Strongly agree.	31.3% (998)	41.4% (950)	z=4.72 ***
				$X^2(4)$=132.40 ***
Animal welfare has only recently become an issue for human societies	No agreement whatsoever.	10.5% (323)	18.4% (428)	z=5.84 ***
	Slightly disagree.	25.6% (787)	25.2% (585)	z=-0.21
	Neither disagree nor agree.	12.7% (390)	8.7% (203)	z=-3.26 **
	Slightly agree.	38.1% (1171)	29.4% (682)	z=-4.08 ***
	Strongly agree.	13.1% (404)	18.2% (423)	z=3.57 ***
				$X^2(4)$=130.10***
Unlike production and companion animals, wild animals cannot experience poor welfare.	No agreement whatsoever.	54.5% (1669)	66.3% (1533)	z=4.18 ***
	Slightly disagree.	31.6% (968)	22.5% (520)	z=-4.75 ***
	Neither disagree nor agree.	7.4% (226)	4.8% (108)	z=-2.98 **
	Slightly agree.	4.0% (121)	3.7% (85)	z=-0.39
	Strongly agree.	2.5% (76)	2.8% (65)	z=0.56
				$X^2(4)$=86.7 ***
All companion animals have excellent welfare.	No agreement whatsoever.	66.7% (2047)	66.8% (1545)	z=0.04
	Slightly disagree.	25.2% (774)	23.5% (544)	z=-0.94
	Neither disagree nor agree.	4.9% (149)	4.4% (101)	z=-0.62
	Slightly agree.	2.1% (65)	3.0% (69)	z=1.50
	Strongly agree.	1.1% (34)	2.3% (53)	z=2.56 **
				$X^2(4)$=17.6 ***
Stereotypic behaviours are an indicator that an animal has suffered poor welfare.	No agreement whatsoever.	5.8% (178)	5.0% (116)	z=-0.95
	Slightly disagree.	17.0% (519)	12.8% (297)	z=-2.91 **
	Neither disagree nor agree.	30.7% (938)	13.4% (311)	z=-9.79 ***
	Slightly agree.	29.7% (909)	31.2% (723)	z=0.75
	Strongly agree.	16.9% (516)	37.5% (870)	z=11.16 ***
				$X^2(4)$=404.90 ***
It is not possible to have high welfare farming systems.	No agreement whatsoever.	39.9% (1223)	36.3% (838)	z=-1.6
	Slightly disagree.	33.8% (1037)	36.0% (832)	z=1.02
	Neither disagree nor agree.	14.0% (430)	10.5% (243)	z=-2.17 **
	Slightly agree.	8.1% (250)	12.8% (296)	z=4.01 ***
	Strongly agree.	4.1% (127)	4.4% (102)	z=0.36

				$X^2(4)=47.64$ ***
All conservation programs consider animal welfare in their strategies.	No agreement whatsoever.	13.6(418)	19.3% (446)	z=3.87 ***
	Slightly disagree.	33.4(1024)	39.6% (916)	z=2.84 **
	Neither disagree nor agree.	29.4(903)	17.6% (406)	z=-6.61 ***
	Slightly agree.	17.7(543)	16.6% (384)	z=-0.73
	Strongly agree.	5.8(179)	7.0% (161)	z=1.23
				$X^2(4)=120.54$ ***

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Table 4 *Student experience post MOOC*

Student Experience	Agreement	N	% of Respondents
The course was enjoyable.	Strongly Disagree	13	0.5%
	Disagree	23	1.0%
	Agree	885	36.9%
	Strongly Agree	1476	61.6%
The course was a valuable use of my time.	Strongly Disagree	14	0.6%
	Disagree	35	1.5%
	Agree	986	41.1%
	Strongly Agree	1362	56.8%
The course was easy to use.	Strongly Disagree	11	0.5%
	Disagree	41	1.7%
	Agree	900	37.6%
	Strongly Agree	1445	60.3%
The course pages looked appealing.	Strongly Disagree	9	0.4%
	Disagree	25	1.0%
	Agree	1043	43.5%
	Strongly Agree	1320	55.1%
The course videos looked good.	Strongly Disagree	15	0.6%
	Disagree	35	1.5%
	Agree	891	37.2%
	Strongly Agree	1456	60.7%
The information in the course was interesting	Strongly Disagree	20	0.8%
	Disagree	29	1.2%
	Agree	793	33.1%
	Strongly Agree	1555	64.9%
The information was at the right level	Strongly Disagree	26	1.1%
	Disagree	177	7.4%
	Agree	824	34.4%
	Strongly Agree	1370	57.2%
A traditional, more paper based approach would have been better.	Strongly Disagree	754	31.5%
	Disagree	1297	54.1%
	Agree	122	6.1%
	Strongly Agree	224	9.4%